Subject: Re: Push-pull versus shorting rings
Posted by Wayne Parham on Wed, 08 Aug 2007 17:14:00 GMT
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To understand how either push-pull drive or shorting rings work, you have to understand what they're trying to fix.

Basically, the problem is that the force that moves the cone is not perfectly linear, and its back and forth motion is not perfectly symmetrical. This is because the magnetic field generated by the voice coil deforms the magnetic field of the fixed magnet. This causes eddy currents in the magnetic circuit, literally modulating the flux. Further, the magnetic circuit is made of several parts, the center pole, top plate and back plate, in addition to the magnet itself. These may saturate at different levels, which will also cause force asymmetry. These are the primary causes of distortion in a loudspeaker.

Push-pull drive is pretty simple to implement, from an engineering perspective. All you have to do is take two identical motors and run them in opposite directions. Position them so that the drive force combines in an additive fashion, and voila! You have push-pull drive. Any asymmetries in an individual drive unit will cancel by using complementary pairs. Essentially you have a strong motor and a weak motor on each half cycle. On each contiguous half cycle, the strong one and the weak one flip.

This can be as simple as taking two identical loudspeakers and running one backwards on the baffle. You have to also reverse polarity on the reverse-mounted driver so their acoustic outputs are in phase. Best results are obtained when the drivers are matched.

You can also take two identical motors run in opposite directions and physically connect them to a common point on a diaphragm. This is another approach that does the same thing. In either case, the solution is essentially mechanical, using two drive units. Each one alternates between being slightly stronger and slightly weaker on each half cycle. The net force is equalized by having them work as a complementary pair.

Shorting rings work a different way. The idea with them is to correct the drive force, itself. To do this, a shorting ring is installed so that the electromagnetic field generated from the voice coil induces a current within the shorting ring. The current flowing through the shorting ring creates its own magnetic field. If the shorting ring is properly sized and placed, it will create a force that is equal and opposite to the difference. The idea is to counteract flux modulation, so that the force in both directions is the same.

A shorting ring is more difficult to do from an engineering perspective. It also requires more machining in the motor core. The size, position and conducting material of the ring contribute to the force it generates, and it must be made to precisely counteract the effects of flux modulation. This is not trivial, and different manufacturers have had varying degrees of success implementing shorting rings. In other words, not all speakers with shorting rings are equal.